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A New Species of the Bee Genus *Eoanthidium* with Extraordinary Male Femoral Organs from the Arabian Peninsula (Hymenoptera: Megachilidae)[1]

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CONTENTS

ABSTRACT *Eoanthidium* (*Eoanthidium*) *bakerorum*, new species (Megachilinae: Anthidiini), is described and figured from individuals collected in Oman and the United Arab Emirates. The new species is distinguished from other *Eoanthidium* sensu stricto and is particularly noteworthy for the presence of a large, possibly glandular opening on the anterior-facing surface of the metafemur in males. The organ resembles in some respects the metatibial glands found in the male orchid bees (Euglossini) of the New World tropics. Possibly this structure functions in a similar fashion and represents an interesting parallel evolution of oil / fragrance-collecting and glandular structures (albeit on the metafemur in *Eoanthidium* versus the metatibia in Euglossini).

Key words: Anthophila, Apoidea, morphology, Oman, taxonomy, United Arab Emirates.

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INTRODUCTION

The bee genus *Eoanthidium*, with 13 described species, is a distinctive group of Old World Anthidiini. The genus is distributed in the eastern Mediterranean, Africa, Asia Minor, Arabia, Central Asia, and into southern India. Presently four subgenera are recognized (Michener, 2000), with the nominate subgenus (the focus of the current contribution) ranging from the eastern Mediterranean to southern Russia and south to Kenya. *Eoanthidium* apparently is related to the more widespread *Anthidiellum* (e.g., Müller, 1996) and, indeed, Warncke (1980) considered *Eoanthidium* a synonym of *Anthidiellum*, a subgenus of *Anthidium* in his system. Unfortunately, little else is known of these attractive bees aside from distribution records of the various species.

Herein I present the description of a new species of *Eoanthidium* from the Arabian Peninsula (Oman and the United Arab Emirates, to be precise). The new species is noteworthy for the possession of anatomical structures reminiscent of those well-documented in male orchid bees (Euglossini) and may represent an Old World analog to the euglossine system (elaborated in the following discussion). Inspection of other *Eoanthidium* revealed that this extraordinary structure is not unique to this new species. The male of *Eoanthidium* (*Eoanthidium*) *clypeare* (Morawitz, 1873b) and *E.* (*E.*) *judaeense* (Mavromoustakis, 1945) were both found to have similar organs, but not as large or well developed as in the new species, which perhaps accounts for their having been hitherto unnoticed. At present only pinned specimens are known of these rare bees and therefore, it has not been possible to examine adequately the internal structure of the organ in *Eoanthidium*. Thus, rather than definitively term the structure in *Eoanthidium* a "gland", the term "organ" has been used herein until such time as fresh specimens are discovered in the field, preserved in fixative, and subjected to histological examination. The new species and its peculiar structures are described here in order to bring them to the attention of melittologists.

Morphological terminology follows that of Engel (2001); the abbreviations F, OD, S, and T are used for flagellomere, ocellar diameter (based on the median ocellus), metasomal sternum, and metasomal tergum, respectively. Head length was measured from the apical margin of the clypeus to the upper tangent of the vertex in facial view; head width was taken as the maximum distance between the outer tangents of the compound eyes from the same aspect.

ACKNOWLEDGMENTS

I dedicate this paper to my late friend and colleague, Dr. Donald D. Baker, world's authority on Palearctic bees, who passed away unexpectedly on 10 May 2004. He is greatly missed but lives on in the unique research collection he developed over many years and which now resides as the Donald & Madge Baker Collection in the Division of Entomology in the Natural History Museum at The University of Kansas.

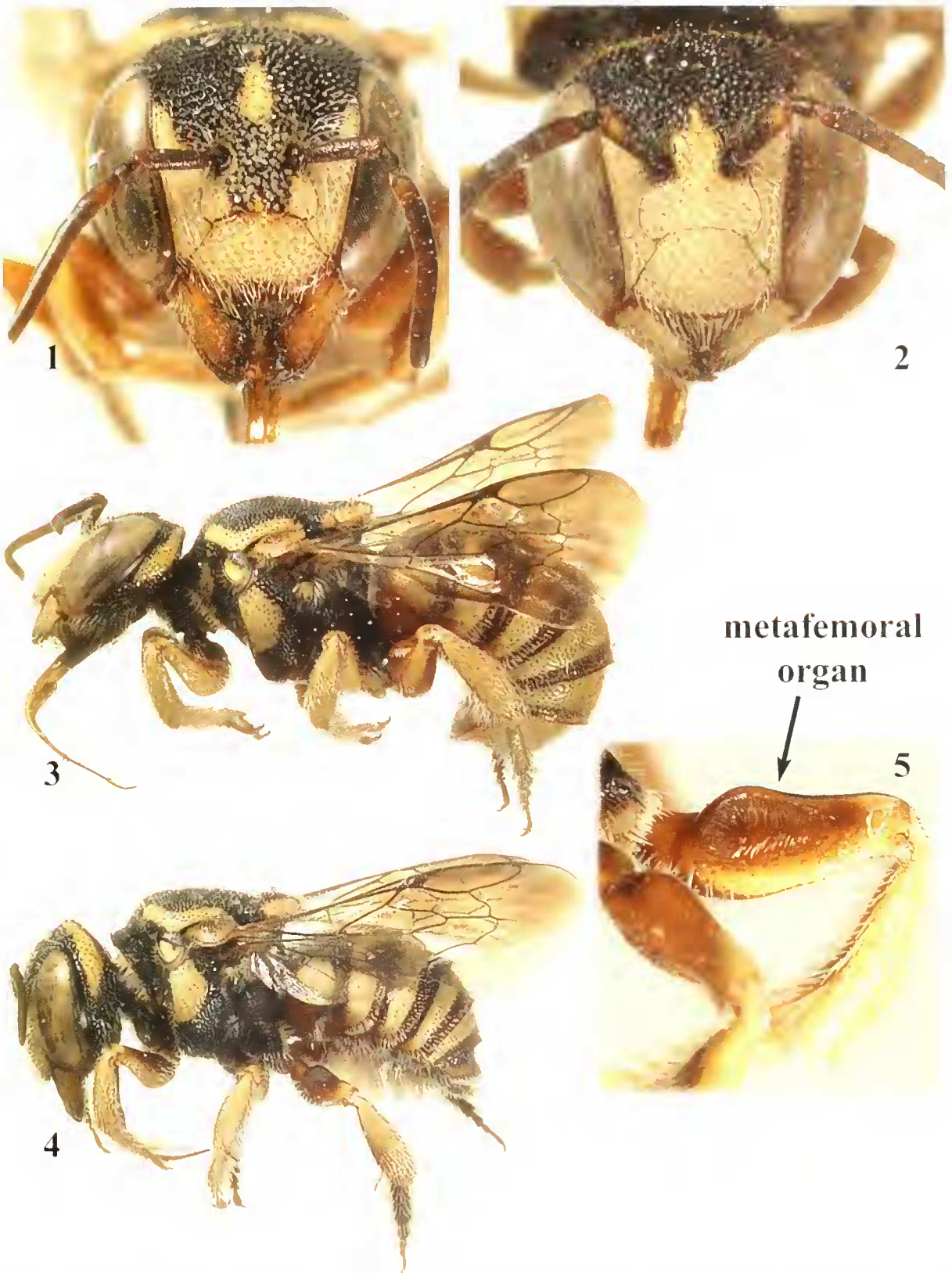
I am grateful to Dr. Leonard Krishtalka for supporting the production of this paper in memory of Dr. Baker, a great benefactor of The University of Kansas Natural History Museum and Biodiversity Research Center. I am also appreciative of the valuable reviews provided by Drs. Jerome G. Rozen and Charles D. Michener.

SYSTEMATICS

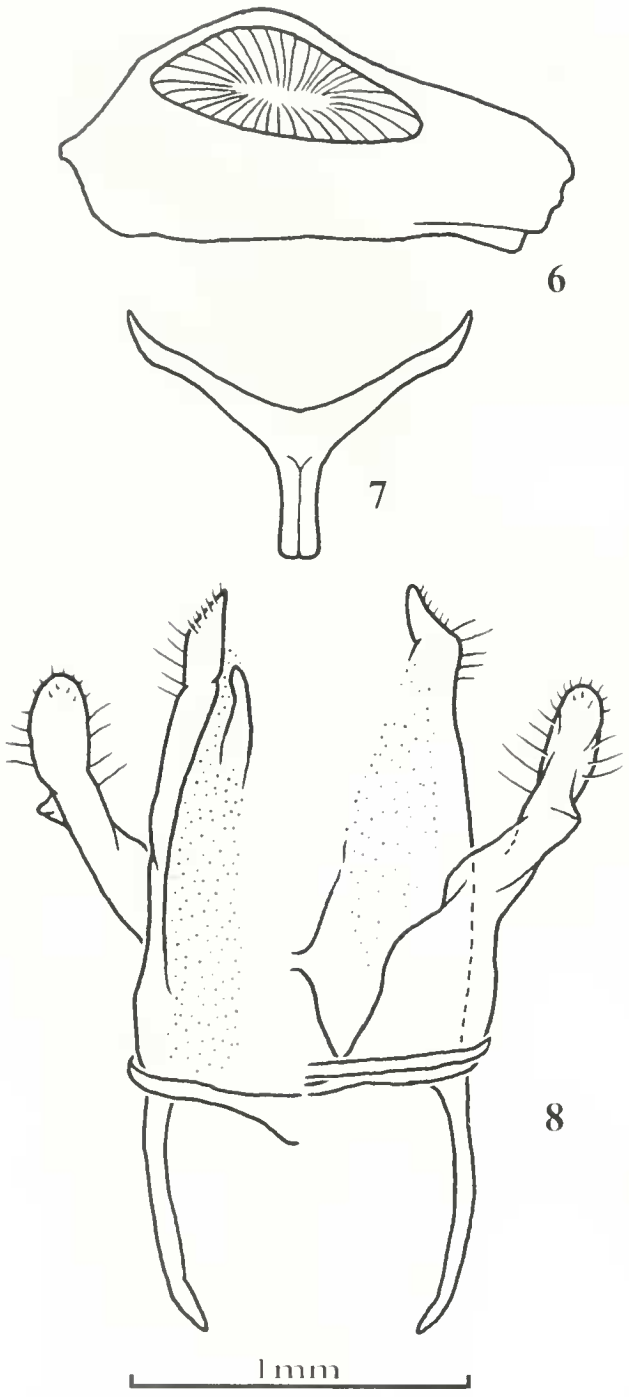
Eoanthidium (*Eoanthidium*) ***bakerorum*** new species
(Figures 1–8)

Diagnosis.—The new species is most similar to *E. clypeare*. Both species share the presence of the metafemoral organ in males (albeit significantly smaller in males of *E. clypeare*, in which the opening is confined to a small, dorsal patch near the metafemoral base). *Eoanthidium bakerorum* differs from *E. clypeare* by the less extensive yellow of the metasoma (bands beyond T1 complete and much broader in *E. clypeare*), the tapering yellow of the face between the antennal sockets (blunt termination of the yellow between the antennal sockets in males of *E. clypeare*), and in traits of the terminalia. *Eoanthidium bakerorum* is also similar to *E. arabicum* Pasteels, 1980, described on the basis of two females from Yemen. The new species differs from *E. arabicum* in females by the more elongate vertex that is slightly more than 2OD in length as measured from the posterior border of the lateral ocellus to the preoccipital ridge (vertex length in *E. arabicum* slightly less than 1OD), by the presence of a series of irregularly-shaped spines along the margin of the sixth sternum (a single, median, triangular spine in *E. arabicum*), and the absence of a shallow, medioapical notch or depression along the posterior margin of the sixth tergum (depressed or notched in *E. arabicum*). The male of *E. arabicum* remains unknown and it would be fascinating to learn whether it possesses a metafemoral organ or incipient homologous structures.

Description.—Male. Total body length 9.1 mm (7.3–9.1, $n = 6$); forewing length 6.0 mm (5.3–6.1, $n = 6$). Head slightly wider than long [length 2.3 mm (1.9–2.4, $n = 6$), width 2.7 mm (2.4–2.7, $n = 6$)]. Gena narrower than compound eye in profile. Vertex 2OD in length as measured from posterior border of lateral ocellus to preoccipital ridge. Ocellocular distance 2OD; distance between toruli 1.5OD;



Figs. 1–5. *Eoanthidium* (*Eoanthidium*) *bakerorum*, new species. 1. Facial view of female. 2. Facial view of male. 3. Lateral habitus of male. 4. Lateral habitus of female. 5. Oblique view of male metafemur depicting metafemoral organ.



Figs. 6–8. *Foanthidium* (*Foanthidium*) *bakerorum*, new species, male. 6. Dorsolateral view of metafemur of paratype. 7. Eighth sternum. 8. Cleared genitalia (left half is ventral view, right half is dorsal view), stippled areas are exceedingly weakly sclerotized (nearly membranous) regions.

torulus-ocular distance 1.25OD. Mandible tridentate, upper tooth separated from mid-tooth by its width. Intertegular distance 2.1 mm (1.8–2.1, $n = 6$). Forewing with basal vein confluent with cu-a, basal vein relatively straight; first submarginal cell approximately equal in length to maximal length of second submarginal cell; anterior border of second submarginal cell approximately one-half length of posterior border; first free abscissa of Rs beyond Rs+M straight; 2rs-m arcuate; 1m-cu entering second submarginal cell near basal third of cell length; 2m-cu distad 2rs-m by approximately four times vein width. Metafemur dorsally swollen in basal half to two-thirds, with large, presumably glandular orifice occupying most of dorsolateral surface except toward apex (Figs. 5, 6). Male terminalia depicted in figures 7 and 8.

Head and mesosoma black except as follows (Figs. 2, 3): antenna dark brown, with yellow spot on inner apical surface of scape; mandible yellow except at apex; clypeus and face below level of antennal sockets (including supraclypeal area) yellow, yellow extends between antennal sockets to a point nearly one-half distance between median ocellus and level of antennal sockets, and along inner borders of compound eyes to about 1.25OD from upper tangent of compound eyes; narrow, transverse yellow band anterior of preoccipital ridge, band extending laterally and broadening to gena, occupying most of upper half of gena; yellow patch on postgena immediately behind posterior mandibular articulation; pronotal lobe yellow; upper, anterior half of mesepisternum yellow; patch of yellow along upper border of metepisternum; tegula yellow except for brown patch medially; lateral margins of mesoscutum yellow, yellow continuing along anterior margin except interrupted medially; posterior half of axilla yellow; scutellum yellow except for posterior-directed triangle of black from anterior margin to point medially on posterior margin. Legs yellow except as indicated: anterior half of procoxa, anterior and inner surfaces of protrochanter, profemur, protibia, and inner surface of protarsus brown; mesocoxa black; anterior and dorsal surfaces of mesotrochanter brown; anterior and posterior surfaces of mesofemur brown; inner surface of mesotibia and mesobasitarsus brown; remainder of mesotarsus brown; dorsal surface of metacoxa dark brown; integument surrounding metafemoral organ and posterior surface of metafemur brown; inner surface of metatibia and metabasitarsus brown; remainder of metatarsus brown; spurs yellow brown; pretarsal claws (ungues) reddish brown. Forewing membrane lightly infumate, veins black; hind wing membrane subhyaline. Metasomal terga dark brown except as noted: yellow dorsolaterally on T1 (yellow areas separated by more than scutellar width); transverse medial yellow bands on T2–5, each band interrupted medially by narrow, longitudinal brown area, width of brown interruption progressively narrower and weaker on more apical terga, yellow bands on T2 with posterior indentation of brown and those of T3 with small, faint brown spot on bands near midline; T6 entirely yellow; each tergum with broad dark brown apical margins; sterna brown.

Mandible punctate except at apex, punctures coarse and contiguous. Face and gena coarsely and contiguously punctate. Mesosoma coarsely and contiguously punctate except: propleuron imbricate; pre-omaular area with punctures smaller, more shallow, and separated by a puncture width or less, integument between punctures smooth; metepisternum minutely punctate, punctures separated by about a puncture width or less; metanotum imbricate. Propodeum imbricate. Metasomal terga punctate, punctures smaller than those of mesosoma, separated by a puncture width or less, integument between punctures smooth; anterior-facing surface of T1 impunctate and smooth; sterna imbricate. Outer surfaces of leg podites with punctures as described for metasoma.

Pubescence white throughout and differs little from other *Eoanthidium* (e.g., identical to *E. clypeare*). Probasitarsus and protarsomeres 2–4 with elongate, minutely-branched, wavy setae along posterior margin and forming distinct brush (similar to those seen on the forelegs of male Euglossini and employed for collecting aromatic compounds); inner surface of probasitarsus with dense, stiff, short to moderate-length setae forming brush; inner surface of mesotibia and mesobasitarsus with moderately-dense (not obscuring integument) brush of short to moderate length setae; metafemoral organ with dense, elongate setae along margin and covering opening (Figs. 5, 6).

Female. As described for the male except as follows: Total body length 6.7–6.9 mm (n = 2); forewing length 4.7–4.9 mm (n = 2). Head length 2.1–2.2 mm (n = 2), width 2.5 mm (n = 2). Upper and mid-mandibular teeth more blunt than those of male, upper tooth only forming a weak point (does not appear to be result of wear in specimens before me). Intertegular distance 1.9–2.0 mm (n = 2). Apical margin of T6 entire; apical margin of S6 with series of small, irregularly-shaped spines.

Mandible pale brown except apex black; supraclypeal area medially black for width of antennal sockets; yellow oval on frons anterior to median ocellus, maximum width of oval slightly more than 1OD (Fig. 1). Axilla black (Fig. 4); yellow bands on metasomal terga narrower and medial interruptions on T2–5 broader than those of male; T6 pale brown, with narrow, lateral, faint yellow bands widely separated by more than band width.

Pubesence as in male except for usual sexual differences (e.g., female lacking brushes presumed for aromatic compound collection). Metasomal scopa white.

Holotype.♂, UAE [United Arab Emirates], Hatta [actually a wadi in the foothills near Omani border southwest of Al Fujayrah; *vide* Baker, 2004], 17.iv.1981 [17 April 1981], C. G. Roche. The holotype is in the Donald & Madge Baker Collection of the Division of Entomology, Natural History Museum, University of Kansas.

Paratypes.—United Arab Emirates: 3 ♀♀, same data as holotype. 1 ♂, UAE [United Arab Emirates], Hayl [Al Hayl, 56°14′E, 25°04′N, *vide* Baker (2004)], 6-v-1989 [6 May 1989], I. L. Hamer. **Oman:** 2 ♂♂, Oman, Rayy [56°07′E, 24°39′N, *vide* Baker (2004)], 9-iv-1993 [9 April 1993], I. L. Hamer. 1♂, 1 ♀, Oman, Wadi Madha [Mahdah, 55°58′E, 24°24′N, *vide* Baker (2004)], 18-iii-1987 [18 March 1987], I. L. Hamer. All material is in the Donald & Madge Baker Collection of the Division of Entomology, Natural History Museum, The University of Kansas.

Etymology.—The specific epithet is a patronymic honoring the late Dr. Donald B. Baker (1922–2004), world's authority on the Palearctic bee fauna, and his wife Mrs. Madge [Marjorie] W. Baker. Their friendship, hospitality, kindness, generosity, and enthusiastic support for the author have been treasures that I shall never forget.

DISCUSSION

The occurrence of glandular organs on the legs of male bees is not unheard of. The collection of fragrant compounds and its processing in the metatibial glands of male euglossine bees in the New World tropics has been long-known, albeit little understood. These anatomical traits evolved a single time in the orchid bees; the modified metatibia is one of the many apomorphies serving to define crown-group Euglossini (e.g., Kimsey, 1987; Engel, 1999; Michener, 1990, 2000). Male orchid bees collect various aromatics from orchids as well as other sources (e.g., even from recently deceased males: Roubik, 1998) and process these chemicals to produce a blended scent in the glands of their metatibiae. The glands open in the form of an elongate, setose slit on the outer surface of the metatibia and are associated with patches of velvety microtrichiae on the outer surface of the mesotibia. The resulting compound is presumably used as an attractant for females. Males have a series of brushes on the anterior legs which permit them to effectively collect the aromatic compounds from the orchids.

It is remarkable to find such a similar suite of traits in an unrelated lineage of bees. Like the euglossines, *Eoanthidium bakerorum*, and to a lesser extent *E. clypeare* and *E. judaeense*, have a tantalizingly similar orifice, presumbaly glandular, on the hind legs, albeit not nearly as swollen and located on the metafemur rather than the metatibia. I strongly suspect male *E. arabicum* also will be found to have such anatomical traits. Furthermore, the probasitarsi of male *E. bakerorum* possess distinct brushes composed of dense, moderately-elongate, branched setae, nearly

identical to the brushes used by Euglossini for gathering fragrances (oils, resins, &c.). Males of *E. insulare* (Morawitz, 1873a), which lack the metafemoral organ, lacked defined protarsal brushes. Although setose, the distinctively elongate and dense setae forming a brush along the posterior margin of the protarsi of *E. bakerorum*, *E. clypeare*, and *E. judaeense* were not to be recognized in *E. insulare*. While this suggests an association of the protarsal brushes and the metafemoral organ, only observations in the field can confirm whether or not this assertion is correct. Analogs of the euglossine mesotibial structures (e.g., velvety patches) do not occur on the mesotibiae of *Eoanthidium*. It is entirely unknown what the function of the male organ in *Eoanthidium* is but its absence in females (just as in the euglossine example) suggests that males may produce an attractant or stimulant for their mates. If glandular, then it is possible that the product of the male *E. bakerorum* organ is entirely synthesized by chemical pathways intrinsic to the bee, but it would appear far more likely that males harvest some extrinsic compound in a manner similar to orchid bees. Fragrant angiosperms abound throughout Arabia (as well as elsewhere), such as the resinous secretions of the region's famed frankincense (*Boswellia* spp.) and myrrh (*Commiphora* spp.), both of the Burseraceae. It is possible that male *Eoanthidium* visit one or more such plants (either for resins, oils, &) to arrive at a chemical blend which is then processed in their metafemora.

A complete revision and phylogenetic study of *Eoanthidium* would be a greatly valued addition to elucidating the evolution of the metafemoral organ in the genus. From the extremely limited available data, it seems that this structure evolved a single time within *Eoanthidium* proper and is most developed in *E. bakerorum*. However, other species of *Eoanthidium* (males of several of which remain unknown) and even related genera should be explored more extensively for similar structures. A cursory examination of selected species in the subgenera *Clisanthidium*, *Salemanthidium* (*E. tricolor* Pasteels, 1972), and an apparently undescribed species near, or unusual variant of, *E. semicarinatum* Pasteels, 1972 (specimens from Pakistan rather than southern India) in *Hemidiellum* failed to find any such organ. I urge melittologists and naturalists to seek *E. bakerorum* and its relatives in the field (preserving specimens in fixatives to permit histological study of the metafemoral organ), to discover their nests and floral associations, and to elaborate the natural history of these remarkable bees.

LITERATURE CITED

Baker, D. B. 2004. Hymenoptera collections from Qatar, the United Arab Emirates and Oman. Beiträge zur Entomologie 54(1): 97–105.

Engel, M. S. 1999. The first fossil *Euglossa* and phylogeny of the orchid bees (Hymenoptera: Apidae; Euglossini). American Museum Novitates 3272: 1–14.

Engel, M. S. 2001. A monograph of the Baltic amber bees and evolution of the Apoidea (Hymenoptera). Bulletin of the American Museum of Natural History 259: 1–192.

Kimsey, L. S. 1987. Generic relationships within the Euglossini (Hymenoptera: Apidae). Systematic Entomology 12(1): 63–72.

Mavromoustakis, G. A. 1945. On some anthidiine bees (Apoidea) from Palestine – Part II. Annals and Magazine of Natural History, series 11 12: 112–117.

Michener, C. D. 1990. Classification of the Apidae (Hymenoptera). University of Kansas Science Bulletin 54(4): 75–164.

Michener, C. D. 2000. *The Bees of the World*. Johns Hopkins University Press; Baltimore, MD; xiv+[1]+913 pp.

Morawitz, F. 1873a [1874]. Drei neue griechische *Anthidium*. Horae Societatis Entomologicae Rossicae 10(2/4): 116–123. [NB: publication date was 13 September 1874, *vide* Pesenko and Astaturova, 2004]

Morawitz, F. 1873b [1874]. Die Bienen Daghestans. Horae Societatis Entomologicae Rossicae 10(2/4): 129–189. [NB: publication date was 13 September 1874, *vide* Pesenko and Astaturova, 2004]

Müller, A. 1996. Host-plant specialization in western Palearctic anthidiine bees (Hymenoptera: Apoidea: Megachilidae). Ecological Monographs 66(2): 235–257.

Pasteels, J. J. 1972. Révision des Anthidiinae (Hymenoptera Apoidea) de la région indo-malaise. Bulletin et Annales de la Société Royale Belge d'Entomologie 108: 72–128.

Pasteels, J. J. 1980. Notes sur les Megachilidae (Hymenoptera, Apoidea) d'Arabie et des regions desertiques limitrophes. 2. Especes nouvelles des d'Anthidiinae. Bulletin et Annales de la Société Royale Belge d'Entomologie 116(4–6): 91–98.

Pesenko, Yu. A., and Y. V. Astaturova. 2004. Annotated bibliography of Russian and Soviet publications on the bees 1771–2002 (Hymenoptera: Apoidea; excluding *Apis mellifera*). Denisia 11: 1–616.

Roubik, D. W. 1998 [1999]. Grave-robbing by male *Eulaema* (Hymenoptera: Apidae): Implications for euglossine biology. Journal of the Kansas Entomological Society 71(2): 188–191.

Warncke, K. 1980. Die Bienengattung *Anthidium* Fabricius, 1804 in der Westpalaarktis und im turkestanischen Becken. Entomofauna 1(10): 119–209.